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Ogden R. Lindsley and the Historical Development of Precision Teaching

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This paper presents the historical developments of precision teaching, a technological offshoot of radical behaviorism and free-operant conditioning. The sequence progresses from the scientific precursors of precision teaching and the beginnings of precision teaching to principal developments since 1965. Information about the persons, events, and accomplishments presented in this chronology was compiled in several ways. Journals, books, and conference presentations provided the essential information. The most important source for this account was Ogden Lindsley himself, because Lindsley and his students established the basic practices that define precision teaching.

Key words: precision teaching, historical analysis, Standard Celeration Chart, Ogden R. Lindsley

A worthwhile history of a science covers the people, dates, discoveries, inventions, and other events that materially contributed to its growth as a science. Because no science remains static, the record of events shows how a science evolves; identifies where and how principles, methodology, and technology arose; points to trends, innovations, and false starts; and projects some possible directions a science will take. Sciences of behavior are no different: Behavioral verbal communities have presumably benefited from previous elucidation of how a science of behavior has emerged. One part of behavioral science and technology for which a dearth of historical information exists is the field of precision teaching. The history described in this paper may remedy this lack, while at the same time publicly noting the significance of precision teaching both to behavior analysis and to education.

Why should we focus upon dates, events, and people? We often hear that history must be something more than names and dates, and it ought to be more. It is, however, mainly dates, events, and people that provide a historical context for evaluation. Charles Darwin, for example, articulated a theory of evolution before Gregor Mendel's discoveries in genetics became well known, and after many biologists across several centuries had developed various taxonomies and classified and reclassified organisms. Knowing that context permits us to understand the development of that science and possibly project future directions. Dates also mark the time lags between invention and application (Fuller, 1981); by chronicling events across successive calendar units, dates reveal trends in scientific theory, technology, and terminology (e.g., see Hellemans & Bunch, 1988).

Often in the history of science, the development of a science or technology pivots around the work of a single individual. That person may recast the direction a science takes, may articulate a new paradigm of the sort Kuhn (1970) discusses, or may share valuable empirical observations, experiments, and findings. We recognize, for instance, the overarching influence of B. F. Skinner upon contemporary analysis of behavior. Precision teaching is no different; it had its founder, too. As a part of the behavioral science originally initiated by Skinner (1938), precision teaching reflects the many contributions of Ogden R. Lindsley.

Although a single individual may "found" a science or technology, that person never operates in a vacuum. A unique set of circumstances and influences converges to forge a scientific repertoire selected for its value to a verbal community of scientists, or to society. Thus, an adequate accounting of a sci-

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ence must not only consider what a scientist does, but should also identify the context and influences over that person's behavior. What professors inspired or influenced a line of research? What teachers suggested areas in which fruitful investigation could occur or served as role models? What books or other sources played a salient role? What other scientists or associates contributed through their communications and interactions?

The present paper takes up these questions and from them seeks to elaborate the history of precision teaching principally through examination of the influence upon and contributions made by Ogden R. Lindsley. Though we recognize that Lindsley did not design or discover everything pertinent to precision teaching, it is fair to claim that precision teaching would not exist without him.

Why should we develop a history of precision teaching? As a measurably superior instructional technology, one that is behaviorally based, precision teaching resides among a handful of effective behavior-change technologies to which students have a right (Barrett et al., 1991). Although not officially recognized as a branch of behavior analysis (e.g., the Association for Behavior Analysis [ABA] convention programs do not list it as a separate area), an identifiable community of precision teaching has existed in behavior analysis since before the inception of ABA. Further, precision teaching has carried forward many components of the original operant laboratory science developed by B. F. Skinner that some areas of behavior analysis play down or even drop (e.g., rate of response). Thus, an historical assessment may have value if it allows reexamination of certain features of behavior-analytic science. In addition, this paper reveals some previously unknown information about precision teaching—information that may make the development of precision teaching as an applied science seem less capricious to some. We answer the question of why the Standard Celeration Chart is printed in light blue, for example—a question of more than trivial merit!

Because Ogden Lindsley essentially founded precision teaching, we believed it only logical to interview him to gain his accounting of its development as an applied science. The interviews, conducted in June 1991 and March 1993, provided the direction for the chronology described in this paper, as well as a framework upon which to add information from other sources. To be sure, there are shortcomings attached to reliance upon information supplied by one person, especially when that person represents the focus of study, but where possible we give verification and substantiation from other sources. Figure 1 presents key events in the history of precision teaching.

Scientific Precursors (1748–1964)

Viewing a behavioral repertoire as a sort of nexus, many influences funneled into Lindsley's scientific repertoire, which later determined the direction taken by precision teaching. A number of scientists influenced precision teaching technology and methodology, the approach taken toward education, and even other matters such as Lindsley's attitudes toward publishing (he largely suspended publication from 1972 to 1990). These influential scientists included Julien Offray de La Mettrie, Claude Bernard, Ivan Pavlov, Walter S. Hunter, Carl Pfaffmann, B. F. Skinner, and F. S. Keller (Lindsley, 1991b). Most behavior analysts probably recognize the influence of Skinner on Lindsley and precision teaching, but the influences of these other scientists may have been equally significant.

Julien Offray de La Mettrie (1709–1751) was a French physician and philosopher, who in *L'Homme Machine* (La Mettrie, 1748/1927), a 90-page book written toward the end of his life, applied mechanistic concepts to human behavior by asserting that psychic phenomena had a direct relationship to organic changes in a person's brain and nervous system. La Mettrie's influence on Lindsley was the demonstration that one small book could have a major impact on science,

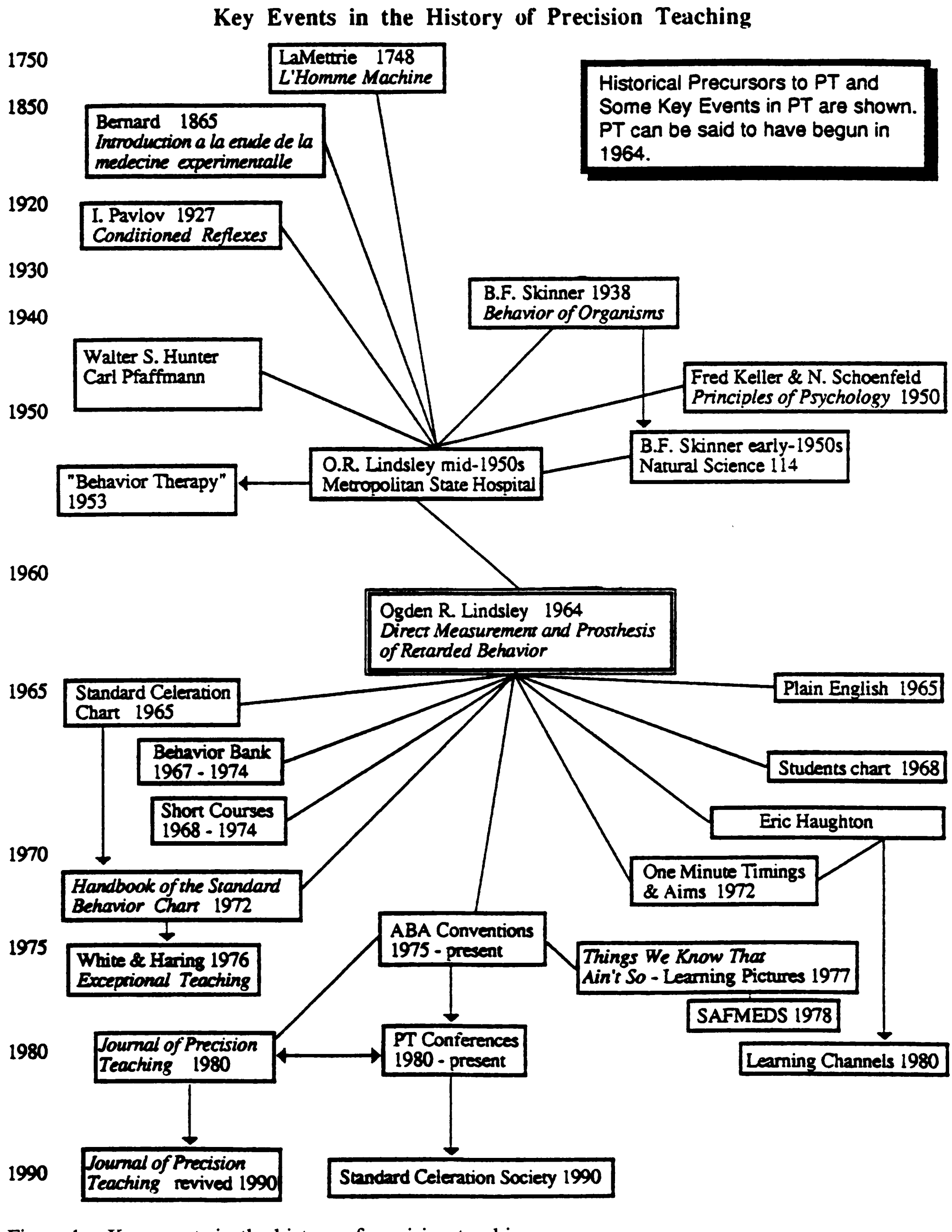

Figure 1. Key events in the history of precision teaching.

and that having the right idea was more important than the number of publications.

Claude Bernard (1813–1878), one of the most famous physiologists in the first half of the 19th century, founded the science of experimental medicine (Bernard, 1865). Bernard adopted single-subject experimental designs, and argued that science develops primarily from inductive reasoning. Precision teaching has always been inductive, not deductive.

Ivan P. Pavlov (1849–1936) conducted the first convincing experimental analyses of behavior. His laboratory research demonstrated how a functional relation between a stimulus and a response could be developed and eliminated (Pavlov, 1927/1965). The basic terms and concepts used in the science of behavior (e.g., conditioning, extinction, discrimination, generalization, unconditioned stimulus, conditioned stimulus) were adapted from Pavlov's research (Michael, 1991). Pavlov influenced Lindsley in three ways: observation, patience, and commitment. Pavlov collected enough experimental data to overprove his conclusions, by repeatedly observing the same behaviors to produce reliable results. Overproving conclusions ensured a high induction ratio of data to discoveries. An induction ratio is computed by taking the number of charts collected and dividing them by the number of these that produced discoveries (Lindsley, 1993).

Furthermore, Pavlov maintained a high level of patience in his work even through difficult times. Lindsley (personal communication, March 27, 1993) related a story about a time when Pavlov became frustrated by the interruption of small-arms fire outside his laboratory during the Russian revolution. Nevertheless, he stayed in the laboratory collecting data and continuing the experiment. Indeed, while his country was embroiled in the turmoil of the Russian famine, Pavlov continued to commit himself to science. When faced with the difficult choice of closing the laboratory and eating the dogs or continuing the laboratory and starving with the dogs, Pavlov, his family, and his associates chose the latter course. On another occasion, when brought before a revolutionary committee that was interrogating scientists to determine who was to be shot, exiled, or kept on, Pavlov, after sitting through the interrogation session for about an hour, abruptly stood up and before leaving announced, "Gentlemen, I have an experiment. Let me know."

Pavlov himself did not publish, and instead disseminated his research by lectures and addresses (which were transcribed and later published). This deemphasis on publishing influenced Lindsley's own beliefs concerning publication. Lindsley kept research as his first priority, and as with Pavlov, did not want publication contingencies to redirect, alter, or distort his research.

An additional influence from Pavlov, and one shared by B. F. Skinner, was Pavlov's use of frequency to measure behavior. As is evident in *Conditioned Reflexes* (Pavlov, 1927/1965), Pavlov's data consisted of drops per 30 s, a frequency measurement. By watching response frequency, Pavlov could see distributions of saliva drops, frequency jumps, and decelerations of drops in real time.

Walter S. Hunter (1880–1954), a past president of the American Psychological Association and recipient of the President's Medal of Merit, did psychological testing for the U.S. Army during World Wars I and II. Hunter was a behaviorist who taught that all behavior is similar, and even suggested "anthroponomy" as a name for the study of human behavior (Hunter, 1919). His work first convinced Lindsley to accept the behavioristic philosophies that later influenced the development of precision teaching (Lindsley, personal communication, March 27, 1993).

Carl Pfaffmann (1913–), an electrophysiologist, taught Lindsley the tactics and methods of laboratory research. Known for his pristinely elegant design of small equipment, Pfaffmann (1951) used the "teasing technique" to study a single c-fiber in the chorda-tympani nerve (Lindsley, personal communication, March 27, 1993). These laboratory tactics and methods were carried on by Lindsley in his own laboratory at Metropolitan State Hospital, the site of the direct precursor to precision teaching.

Precision teaching inherited six basic tenets from Skinner's experimental analysis of behavior (Lindsley, 1972): (a) consequences control operant behavior; (b) "the learner knows best" (originally stated by Skinner as "the rat knows best," signifying that organisms are simply responding according to whatever contingencies have been arranged); (c) work with observable behavior; (d) monitor frequency daily; (e) use frequency as a universal, standard, and absolute measure of behavior; and (f) adopt a standard display for data.

Fred Keller (1899–), along with W. N. Schoenfeld, developed the first easy-to-read textbook to describe the methods, concepts, and principles for the science of behavior (Keller & Schoenfeld, 1950). Significantly, Keller and Schoenfeld declared that "our best measure of operant strength is *frequency of occurrence.* An operant is strong when emitted often within a given period of time; it is weak when emitted rarely" (p. 50, emphasis in original). Keller and Schoenfeld combined Skinner's work with experimental psychology (Michael, 1991).

Teaching was more important for Fred Keller than publication was. Lindsley modeled his practice of "laying on of hands" after Keller. As a result of Keller's influence and that of Pavlov mentioned earlier, the dissemination of precision teaching has been primarily through conference presentation and workshop rather than through publication (Eshleman, 1990). Lindsley believed that it was a more functional use of time to teach precision teaching directly rather than to write about it. Consequently, in addition to conference presentations and university lectures, Lindsley offered a number of "short courses" (i.e., workshops lasting several days) on precision teaching from 1968 through 1974.

Beginnings of Precision Teaching (1953–1965)

Following an honorable discharge from the U.S. Air Force at the end of World War II, Lindsley attended Brown University and received an AB with Highest Honors in Psychology and an ScM in Experimental Psychology. He then enrolled at Harvard to study for the PhD in Psychology. While a student at Harvard, he accepted a graduate teaching assistantship for Skinner's course Natural Science 114 (the content of this course provided the foundation for Skinner's book *Science and Human Behavior,* 1953) Lindsley's contact with Natural Science 114 taught him the power of behavior shaping and convinced him to use the principles of behavior analysis in the study of psychophysiology with Skinner as his major advisor. He received a PhD from Harvard in 1957.

Lindsley established the first human operant laboratory in 1953 at Metropolitan State Hospital, Waltham, Massachusetts to analyze experimentally the behavior of persons with schizophrenia. This research further verified Lindsley's hunch that frequency of response was the most sensitive measurement for testing the effects of drugs on behavior and that this sensitivity applies to all human behavior. While serving as the director of the laboratory at Metropolitan, he coined the term "behavior therapy" and documented this name in the Boston telephone directory (Lindsley, 1991a). Lindsley devoted a substantial amount of professional time to writing grants and contracts to fund his Behavior Research Laboratory, but believed that writing grants detracted from his scientific research, ultimately motivating him to change his research focus from basic research to applied educational research (Lindsley, 1992).

"Direct measurement and prosthesis of retarded behavior" (Lindsley, 1964) may have been Lindsley's first major publication that specifically addressed the education of persons with special needs. This article emphasized the direct measurement of human behavior. In 1965, Lindsley accepted a professorship at the University of Kansas in special education and participated in the development of data-based classroom instruction in public schools. He also introduced precision teaching to a special education classroom at the Children's Rehabilitation Unit, University of Kansas Medical Center (Lindsley, 1991b). Under his guidance, students self-monitored and charted their pinpointed behaviors and became members of the education team, the student and the teacher making data-based instructional decisions.

By 1965, three pivotal events established precision teaching as a unique, identifiable practice of radical behaviorism: (a) The development of the Standard

Celeration Chart focused classroom instruction on free-operant responding, frequency of response, and celeration of learning, (b) precision teachers charted inner behaviors, and (c) precision teachers adopted plain English for communication.

Development of the Standard Celeration Chart. The Standard Celeration Chart (also referred to here as "the chart") is a standard display of frequency as count per minute, count per week, count per month, or count per year. Frequency is displayed "up the left" (*y* axis) of the chart. Calendar time as days, weeks, months, or years is presented "across the bottom" (*x* axis) of the chart. What makes the chart standard is its display of celeration, which is a linear measure of behavior change across time. Celeration is the next derivative of frequency (rate of response), and is measured as a factor by which frequency multiplies or divides over the celeration period. A celeration period is $\frac{1}{20}$th of the horizontal axis of any Standard Celeration Chart. On a daily chart, $\frac{1}{20}$th of the horizontal axis equals 1 week. A line drawn from the bottom left corner to the top right corner has a slope of 34° on a Standard Celeration Chart. This slope has a celeration value of ×2 (read as "times two"; celerations are expressed with multiples or divisors). A ×2 celeration represents a doubling in frequency every celeration period (Figure 2).

Lindsley brought inductive scientific methods to the classroom with the chart. The chart helps teachers and students discover measurably effective instructional procedures (Binder, 1988). Specific movement cycles (i.e., behaviors) are pinpointed, counted, and charted daily. Instructional aims are specified and are the frequency goals to be achieved during instruction (Haughton, 1972). Typically, correct and incorrect responses are counted and charted separately, and aims are set for both. This correct and incorrect pair, when displayed on the chart, produces a "learning picture" (Lindsley, 1977). Teaching efforts are altered according to decision rules based on learning pictures produced by the celerations of the correct and incorrect pair (White & Haring, 1978).

The Standard Celeration Chart evolved from Skinner's cumulative records that show moment-to-moment changes in behavior as response rate in slopes of standard angles (Lindsley, 1991b). Indeed, early in the development of the experimental analysis of behavior, behavior analysts routinely used cumulative records and included a small grid showing the standard angles for one per minute, two per minute, four per minute, eight per minute, and so on in their published research to illustrate steady-state, transition-state, or transitory-state responding (Skinner, 1976). Lindsley (1979) suggested that Skinner should have called the cumulative record a "standard frequency chart" because of the standard angle slopes. The cumulative record and the Standard Celeration Chart show major changes in the frequency and celeration of behavior. On a cumulative record a constant frequency is a straight line at an angle, and celeration is a curve. A change in frequency produces a curve on the cumulative record. On the Standard Celeration Chart a constant frequency is a horizontal straight line across the chart, and a constant celeration is an angled straight line. The significance of celeration as an angled straight line comes in the opportunity for straight-line projections of the future course of behavior. Precision teachers project celerations to guide educational decisions (Koenig, 1972).

Ogden Lindsley, Eric Haughton (and other graduate students of Lindsley's), Sandy Houston (the administrative assistant), and Helen Brennan (the printer) together developed the Standard Celeration Chart. Lindsley (1991b) acknowledged the significant contributions that Haughton made to the construction of the chart. This team considered several features while designing the chart, including its appearance, paper type, color, durability, and dimensions. Lindsley and the other developers wanted to use a chart with a landscape view to show frequency and celeration, not a portrait view of learning (Lindsley, 1991b). Most com-

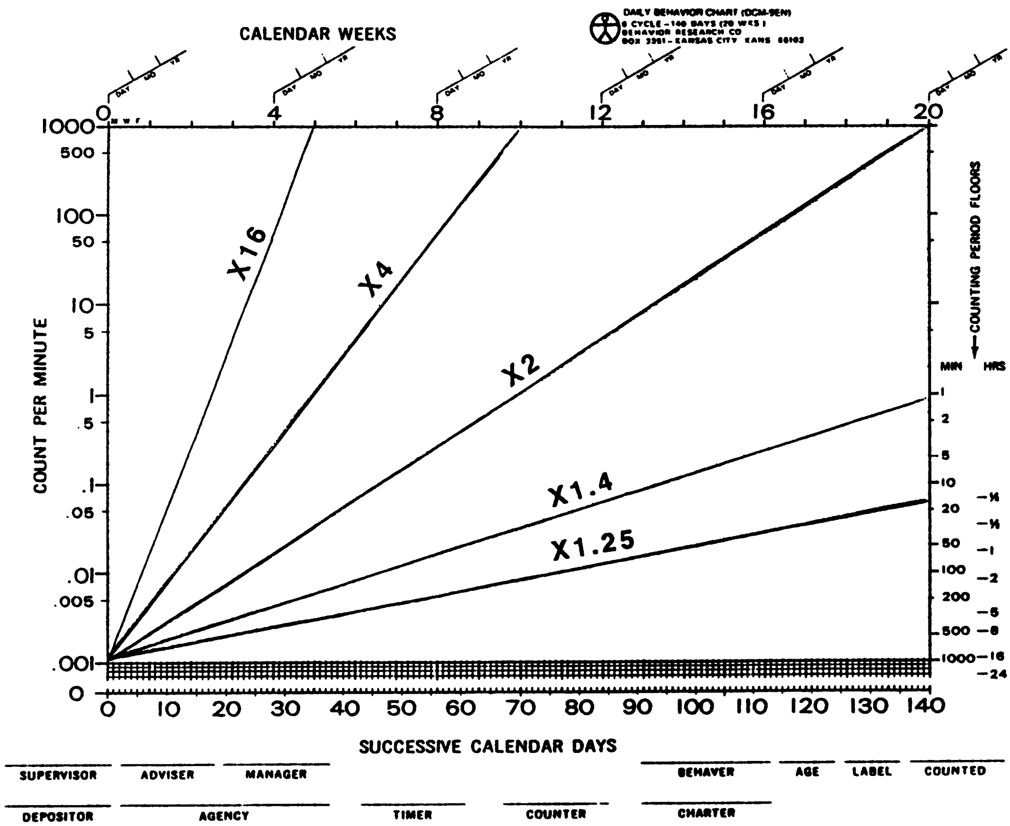

Figure 2. The Standard Celeration Chart, with reference celerations shown.

mercially available semilogarithmic graph paper (i.e., ratio graph paper) used a portrait view, with the vertical axis on the long side of the paper (up the left) and the horizontal axis on the short side (across the bottom). A landscape view reverses these axes.

The paper used to print the chart had to be durable enough to withstand at least 6 months of use by elementary-school students. The charts were first printed on Kodak® paper; however, it lasted only 2 months with daily charting. Lindsley and his graduate students then considered printing the chart on imported cotton paper from Denmark. This paper was more durable than the Kodak paper, but it was available for only a short time. Currently, the chart is printed on the most durable paper made in the United States, Eagle Translucent A paper (Lindsley, 1991b).

The research team evaluated charting accuracy, charting fatigue, and color preferences with charts printed in three shades each of red, orange, yellow, green, blue, and light brown. Most charters preferred a shade of green. The light blue chart, however, produced the highest accuracy of charting and was more resistant to fatigue than green. The chart has appeared in light blue ever since this evaluation (Lindsley, 1991b).

A six-cycle chart covers the full range of all human behavior frequencies (Lindsley, 1991b), spanning a range from one response per 24 hr to 1,000 responses per minute, a ×1,000,000 frequency spread. The number of successive calendar days included on the chart gradually changed from a calendar year to 20 weeks. Lindsley first experimented with a calendar year across the bottom of a 10-in. wide chart designed explicitly to fit an overhead projector screen with a landscape view (Lindsley, 1991b). The day lines were much too close to see the differences between each day. Next, he tried 6 months of day lines and found the lines still too close. Finally, 20 weeks (140 days) across the bottom, a public school semester, was considered acceptable. This gave the chart 20 celeration periods.

Inner behavior included. "Inners" are stimuli and behaviors that only the person experiencing them can directly apprehend and possibly measure. They are not precepts (e.g., rules) or establishing operations such as aversive stimulation or deprivations (Calkin, 1992). Calkin identified thoughts and feelings as the most common inners. In 1965, Ann Duncan was the first person in precision teaching to count and chart inners directly; she presented these data to the 1968 annual convention of the American Psychological Association (Calkin, 1992). In an interesting early variation on the recording of inner behavior, Edwards and Edwards (1970) had 8 pregnant women count every fetal kick during the waking day from the time when the first kick was felt until birth. Their Standard Celeration Charts, published in *Science,* were probably the first published standard charts of inner behavior.

Ann Duncan may have been the first to publish charts of what most of us probably think of as inners, that is, private events such as thoughts and feelings (Duncan, 1971). In 1977, Abigail Calkin began using 1-min counting periods to improve inners (e.g., Calkin, 1981). Calkin (1992) identified 45 projects that directly counted and charted inners. Of these projects, 35 used 1-min counting periods to improve inners such as depression and unpleasant negative self-thoughts and feelings. "Teachers who limit themselves to recording only external, reliability tested behavior lose access to their pupil's thoughts and feelings" (Lindsley, 1990, p. 12).

Plain English emphasized. Lindsley (1972; 1991a) believed that the technical terms and jargon we use to describe teaching and learning should communicate an accurate, unambiguous meaning to parents and the general public. Precision teachers try to use plain English words, acronyms, letter codes, and simple tests to improve communication (Lindsley, 1972, 1991a).

Lindsley began using plain English to describe events and functional definitions while working in the research laboratory at Metropolitan State Hospital (Lindsley, 1991b). As one example, Lindsley believed the laboratory name "Human Operant Laboratory" was technical jargon that would not communicate well; therefore, in 1953 he opened the laboratory using the name "Studies in Behavior Therapy," and by 1955 felt secure enough in the hospital to use the plain English name "Behavior Research Laboratory."

The shift to better language even applied to the Standard Celeration Chart itself. When Lindsley and his team constructed the chart, they considered calling it the "Standard Celeration Graph," but considered this term too neologistic. Thus, they first named it the "Standard Behavior Graph" in 1965. Lindsley, however, wanted more humane terms—you *chart* progress—and by 1972 they had renamed it the "Standard Behavior Chart" (the new name expressed in Pennypacker, Koenig, & Lindsley, 1972). In the 1980s, they again renamed it the "Standard Celeration Chart," because the chart presents standard celerations instead of standard behaviors. Lindsley (personal communication, March 27, 1993) said he realized his initial fear of calling it a Standard Celeration Chart was an error.

Other terminology changed as well. "Correct and error rates" changed to "accuracy pair," and then by 1976, the term "two-line learning picture" became the plain English equivalent to "correct and error rates" (Lindsley, 1977, 1991b). Lindsley believes that we should not use technical jargon if plain English terms provide better communication, and with the use of plain English, teachers, teacher educators, and researchers will discover improved instructional technologies. Finally, Lindsley believes that persons are more apt to be creative and see new relationships when they use the language of their childhood. The more recently acquired the language, the less is one's familiarity with it, and the fewer the connections to other words in the language. As Lindsley (personal communication, March 27, 1993) noted, childhood words have "a thousand fishhooks" attached to them. From the perspective of Skinner's (1957) analysis of verbal behavior, this claim suggests that the frequency of intraverbal responses may be a function of one's experience with language in combination with the complexity of verbal stimuli.

Developments of Precision Teaching (1966–1993)

During the last 27 years, precision teaching has continued to grow and develop from its beginnings with Lindsley and his graduate students at the University of Kansas. Below, we present highlights of these developments, including examples of common techniques associated with precision teaching, dissemination efforts, demonstration projects, and the professional indicators of a maturing practice—the *Journal of Precision Teaching,* annual conventions, and the recently established Standard Celeration Society.

SAFMEDS. The acronym SAFMEDS (Say All Fast, a Minute Every Day, Shuffle) is a practice and assessment procedure developed by Lindsley and Stephen A. Graf, a professor at Youngstown State University, in 1978. SAFMEDS helps students attain high academic fluency with daily 1-min practice sessions. Lindsley designed flash cards for use in his course "Supervision of Instruction" at the University of Kansas (Lindsley, 1980). He soon realized that these were not simply flash cards but constituted an instructional methodology. McGreevy (1983) described the methodology:

> Without any practice, shuffle your SAFMEDS and see how many answers you can say in one minute (have someone time you). Count your correct and incorrect answers. Repeat this 1-minute exercise each day until you can say at least 40 and hopefully 60 answers in the 1-minute period. Keep your daily "counts." The first few days you will probably have only a few correct and many incorrect. That's fine. You will not be punished for your mistakes, because they are "opportunities to learn." (pp. 1–2)

As Lindsley (1983) noted, the use of SAFMEDS dispelled some common myths about how we learn. Research with SAFMEDS generated a number of unexpected findings, which Lindsley characterizes as "counterintuitive." These counterintuitive discoveries were induced, among other inductive discoveries, from a data base consisting of 11,900 charts (Lindsley, 1993). Each word in the acronym SAFMEDS relates to a counterintuitive discovery.

1. One myth is that "thinking the answer is as good as saying it," but actively saying the answer leads to better learning.
2. A second myth is that it is "best to learn part first (e.g., 10 cards), and then later assemble them," but working with the entire set leads to better learning.
3. A third myth is that it is "best to learn the cards in sequence and then later shuffle them," but by doing so the student learns the order, not the relationship.
4. A fourth myth is that "the best strategy is to start slow and build up speed as one learns," but, in fact, steeper celeration slopes result when the learner starts out fast. Going fast from the start is counterintuitive, especially because the learner is unlikely to know the relationship between text and response. Would not many errors result?
5. A fifth myth is that it is "best to make few or no errors as you learn," when in fact high-error learning is best. Errorful learning approximates the real world; errorless learning does not.
6. A sixth myth is that "learning cannot occur without understanding," when actually the understanding comes after the learning.

These myths were disproven by SAFMEDS, which means that the concept relates not only to a procedure for doing flash cards, but also has more far-reaching implications.

Counting periods and sprints. In 1967, Harold Kunzelmann in Seattle, Washington, and Eric Haughton, in Eugene, Oregon, simultaneously advanced the practice of using a short duration (e.g., 15 s, 30 s, 60 s) as a counting period for the frequent assessment of performance (Calkin, personal communication, March 1992). The most common counting period for the academic assessment interval became 1 min; for example, a student reads addition facts and quickly writes answers for 1 min. Recently 10-, 15-, and 30-s "sprints" have been used as a practice procedure for developing fluent behavior. The use of computer-generated "practice sheets" may supersede SAFMEDS in the deployment of "sprints" for instructional assessment purposes (Auman, Graf, & Lindsley, 1993).

Student self-charting. From the beginning of precision teaching, Lindsley insisted that learners self-count and self-chart their performances. Clearly by 1968, precision teachers established that most learners, even first-grade students, can self-count, chart, and make instructional decisions based on charted data (Bates & Bates, 1971; Lindsley, 1990). Self-charting is cost effective and reliable, produces better learning than a teacher-charted system, creates trust between the student and teacher, and gives the learner ownership of the data. Ownership inclines students to look at their learning as they chart their performance. Lindsley maintains that students are less likely to look at their data, much less consider those data when making decisions, from teacher-made charts (Lindsley, 1990).

The behavior bank. Lindsley and his associates (Lindsley, Koenig, Nichol, Kanter, & Young, 1971) established a "behavior bank" in 1967 using an IBM® mainframe computer to deposit behavior frequencies and descriptions of procedures used with precision teaching (Lindsley, 1990). The bank was a depository to give teachers access to measurably effective instructional procedures (Lindsley, 1991c). Lindsley derived five major conclusions from the 32,190 projects deposited in the bank: (a) All deposits use a multiple scale to chart behavior frequencies; (b) these data are sufficient to warrant an induction of general conclusions about teaching and learning; (c) data in the behavior bank are similar to data in refereed journal articles; therefore, banked projects are as professionally valuable as journal articles; (d) bounce (i.e., behavioral variability) and celeration are independent of frequency; and (e) different instructional procedures are equally effective for the same behavior—"different strokes for different folks" (Lindsley, 1991c). Teachers and researchers deposited data, but they did not ask for the summary results or refer questions to the bank. The behavior bank did not succeed (Lindsley, 1990).

Short courses. Lindsley developed "short courses" to teach and disseminate precision teaching, modeling them on the workshops used to teach people-centered therapy (e.g., Rogers, 1961). Many teachers who participated in these short courses between 1968 and 1974 did not deposit data and procedural descriptions in the behavior bank. Short-course graduates, however, became enduring precision teachers.

Projects and applications. Because precision teachers collect large amounts of data, hundreds of thousands of charted projects document that precision teaching produces measurably effective instruction (Binder & Watkins, 1990). Several specifically directed evaluations involving whole schools and learners with a variety of special instructional needs also show that the use of precision teaching greatly facilitates learning (e.g., Beck & Clement, 1991).

The Great Falls Precision Teaching Project is perhaps the most widely cited of these demonstrations. In 1972, the Special Education Department of the Great Falls (Montana) public schools used precision teaching to improve basic skill deficits of elementary and secondary students with mild disabilities (Beck, 1977). Ray Beck was the Director of Special Education and project director of the Precision Teaching Project. The precision teaching model used (a) daily 1-min assessments of basic academic skills, (b) high instructional aims (e.g., 70 to 90 correct digits per minute in math, 180 to 200 correct words per minute in oral reading), (c) daily charting, (d) data-based instructional decisions, and (e) 10,000 basic skill practice sheets (Beck & Clement, 1991). The United States Office of Education's Joint Dissemination and Review Panel examined the effectiveness of this model in 1975 by analyzing 19 precision teaching–control group comparisons. Fifteen of the precision teaching groups were significantly superior on posttest examinations (Beck & Clement). Students judged to be "remediated" during the 1974 project evaluation were reevaluated in 1977. Standardized achievement tests, daily and direct classroom performance measurements, and teacher judgments supported the conclusion that these students were still academically successful.

Even though the Great Falls Precision Teaching Project has been widely cited, many other exemplary centers of learning continue to document the successful use of precision teaching. These include the Center for Individualized Instruction, Jacksonville State University, Claudia McDade, Director (McDade & Goggans, 1992); Haughton Learning Center, Elizabeth Haughton, Director (Haughton, Freeman, & Binder, 1992); Malcolm X College, T. V. Joe Layng, Principal (Johnson & Layng, 1992); Morningside Academy, Kent Johnson, Director (Snyder, 1992b); Precision Learning Systems, James Cowardin, Vice President (Snyder, 1992a); Precision Teaching and Management Systems Inc., Carl Binder, President (Snyder, 1992c); and The Learning Center, Michael Maloney, Director (Maloney & Humphrey, 1982).

The journal. Patrick McGreevy published the first edition of the *Journal of Precision Teaching* (*JPT*) in 1980. As the first editor, McGreevy planned to provide a permanent plain-English collection of precision teaching applications and research for classroom teachers. *JPT* suspended publication in 1986 but was revitalized in 1990, with Claudia McDade, Director of the Center for Individualized Instruction, Jacksonville State University, serving as editor.

Conferences and the society. The precision teaching community held its 11th annual International Precision Teaching Conference in Salt Lake City in March 1993. Earlier, leadership among participants in the 1990 Precision Teaching Conference, Boston, planned for the development of a professional association for persons who use the Standard Celeration Chart. A suggested name for the proposed organization was the Standard Celeration Society, which was designed to be an overarching society with subsocieties covering applications such as precision teaching, precision business management, and precision social work. The official Standard Celeration Society became a reality in March 1992 at the 10th Annual Precision Teaching Conference held at Park City, Utah.

Summary

Three events have established precision teaching as a unique, identifiable behavioral discipline, technology, and profession: (a) The development of the Standard Celeration Chart focused classroom instruction on free operant responding, frequency of response, and celeration of learning; (b) precision teachers charted outer and inner behaviors; and (c) precision teachers adopted plain English. As a discipline, it has developed and maintained a loyal adherence to several important scientific precepts, including inductive research strategies; direct measurement of behavior; the use of standard, absolute, and universal measures of behavior; and an emphasis on clear communication, carried out in a graphical mode on charts that have standard slopes. As a science and technology, it has contributed important discoveries about human behavior, many of which are counterintuitive. It also has provided practical means for assessing performance and learning changes, and the ability for teachers to make data-based instructional decisions. Along with these contributions, precision teachers have developed a number of instructional techniques, all of which are instrumental in developing fluent and persistent behavioral repertoires. Precision teaching continues to be an ongoing profession that includes public and private school teachers, administrators, and university academicians.

Precision teaching itself is not an instructional system or curriculum, but is a way of evaluating instructional effectiveness and making instructional decisions (White, 1986). As such, it could be a potential technological partner for all other methods of measurably effective behavioral instruction that focus on behavior acquisition. For example, many teachers integrate precision teaching in harmony with Engelmann and associates' (Engelmann, 1991) direct instruction materials, the personalized system of instruction (see Johnson & Layng, 1992; McDade & Goggans, 1992), computer-programmed instruction (McDade & Goggans, 1992; Snyder, 1992a), and many instructional procedures for developing fluent behavior (Binder, 1987, 1988; Binder, Haughton, & Van Eyk, 1990). We predict an accelerating trend of a partnership between precision teaching and other measurably effective instructional methods.

Finally, our history of precision teaching reflects the many contributions of Ogden R. Lindsley, a mentor, teacher, and scientist. As mentor and teacher, Lindsley (1972) taught precision teachers to observe six basic tenets from Skinner's experimental analysis of behavior: (a) Consequences control operant behavior; (b) "the learner knows best"; (c) work with observable behavior; (d) monitor frequency daily; (e) use frequency as a universal, standard, and absolute measure of behavior; and (f) use a standard display for data. As scientist, Lindsley modeled four values of the natural sciences for precision teachers to follow: (a) Be tough when collecting data, (b) be slow to publish, (c) be careful and cautious about conclusions, and (d) collect more data than necessary because large collections of data tend to produce the high induction ratios characteristic of Pavlov's and Skinner's laboratory research (i.e., ratio of quantity to number of discoveries). These four basic values guide the advancement of precision teaching.

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